Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 (2) : 117-121 (July-2022) Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Genetic Assessment of Desi Cotton (*G. arboreum* L.) Genotypes for Drought Tolerance Related Traits under Water Stress Condition

U. Nikhil Sagar[1,2], B.V. Ravi Prakash Reddy[2*], K. Mohan Vishnuvardhan[2], A. Prasanna Rajesh[1], E.S.V. Narayana Rao[1], N. Sabitha[1], D. Lakshmi Kalyani[2] and Y. Rama Reddy[2]

[1]*Acharya N.G. Ranga Agricultural University, Agricultural College, Mahanandi-518502*

[2]*Acharya N.G.Ranga Agricultural University, Regional Agricultural Research Station, Nandyal-518502*

**Corresponding Author Email : bvrpreddy@gmail.com*

Abstract

Cotton is the important fiber crop, which occupies the three percent of total arable land in the world. The productivity of the cotton crop is mainly affected by the many biotic and abiotic factors in India. The present study was carried out to screen the 24 desi cotton genotypes for drought tolerance related traits under water controlled and stress condition. The analysis of variance revealed that the presence of significant difference among the genotypes under normal and stress condition. The traits primary root length and root to shoot ratio were significantly higher under stress condition indicating that these can be used for screening large scale germplasm for drought tolerance ability. Further, root dry weight, shoot dry weight, total dry weight and root to shoot ratio were significantly and positively correlated with each other under both normal and stress conditions indicating the importance of biomass traits under stress condition. The genotypes NDLA 2963, NDLA 2965, NDLA 2958, NDLA 2976 and NDLA 3028 were shown higher total and shoot biomass under stress condition and found to be tolerant. These genotypes could be used for future breeding programme for improvement of drought tolerance ability in desi cotton.

Key words : *Desi cotton, stress condition, drought tolerance, biomass traits.*

Introduction

Cotton is one of the most important strategic fiber crops in the global textile industry and plays a significant role in the industrial and agricultural economy of the country. Cotton belongs to the Genus *Gossypium* and the family Malvaceae. Among fifty species of the *Gossypium* genus, 45 are diploid and five are allotetraploid. Among these species, only *G. hirsutum* and *G. barbadense* are tetraploid, whereas *G. arboreum* and *G. herbaceum* are diploid, which are presently cultivated (Malik *et al.,* 2014). Cotton is grown all over the world, and is the main agriculture crop of so many countries.Availability of water in adequate quantities is a prerequisite for normal vegetative growth and development of cotton plants for producing lint yield as per the varietal potential of the specific cultivar (1,2,3). The changing climate scenario has multiplied the intensity as well as the frequency of different abiotic stresses such as heat, salinity, and drought. However, in recent years, drought stress (DS) has emerged as one of the most lethal and growth hampering factors that has led to a serious decline in cotton production worldwide.

The important parameters for estimating drought tolerance in cotton are primary root length, root dry weight, shoot dry weight, root to shoot ratio, total dry weight and relative water content under both control and treatment conditions.Screening of cotton genotypes under heat and drought stress is one of the essential protocols that can be used to select a large number of populations within the shortest period. This approach can be used to differentiate the agronomical, physiological, and biochemical attributes of cotton genotypes contrasting for drought and heat stress tolerance (4,5) Studies of cotton genotypes at different water stress levels exhibited that the water content decrease with an increase in drought stress (6). (7) reported that photosynthesis had positive correlation with relative water content under both control and drought conditions whereas the trait had positive correlation with boll retention percentage in stressed conditions. (2) carried out a study to determine the effects of water stress on genetic variability of root and shoot traits. Fresh and dry shoot weights were positively correlated with all seed traits. Therefore, the presence of significant variability coupled with positive correlation among various shoot and root traits is the criteria for genetic improvement of drought tolerance in cotton. Keeping this in view, the present study was framed with objectives of assessment of genetic variability among the desi cotton genotypes for drought tolerance related traits as well as the correlation analysis among the root and shoot traits under both control and treatment conditions in desi cotton.

Materials and Methods

The present investigation was carried out using 24 diverse desi cotton genotypes developed at Regional Agricultural Research Station, Nandyal including Aravinda, Srinandi,

Received : Mayl-2022; Revised : May-2022; Accepted : May-2022

Table-1 : ANOVA table of six drought related traits in cotton.

Traits	Mean sum of squares			CV (%)	Heritability
	Genotype (G)	Drought (D)	G × D		
PRL	37.03***	1772.20***	24.68***	19.05	0.33
RDW	0.10***	0.16***	0.00***	9.14	0.98
SDW	0.85***	12.14***	0.12***	2.84	0.86
RSR	0.04***	0.18***	0.00***	9.11	0.88
TDW	1.35***	15.09***	0.13***	3.96	0.90
RWC	36.56***	9092.10***	17.42***	2.67	0.52

*** significant at p<0.001.
PRL = Primary root length, RDW = Root dry weight, SDW = Shoot dry weight, RSR = Root to shoot ratio = TDW = total dry weight, RWC = relative water content, CV = coefficient of variation.

Table-2 : Descriptive statistics of six drought related traits in cotton.

Traits	Control			Treatment		
	Mean	SD	Range	Mean	SD	Range
PRL	7.26	2.04	4.9 – 12.87	14.28	4.05	8.83 – 25.77
RDW	0.28	0.13	0.13 – 0.53	0.21	0.13	0.08 – 0.46
SDW	1.34	0.42	0.91 – 2.22	0.76	0.38	0.29 – 1.52
RSR	0.21	0.09	0.08 – 0.39	0.28	0.08	0.10 – 0.44
TDW	1.62	0.50	1.04 – 2.60	0.97	0.49	0.37 – 1.85
RWC	91.88	1.35	88.09 – 93.92	75.98	4.02	67.29 – 85.52

PRL = Primary root length, RDW = Root dry weight, SDW = Shoot dry weight, RSR = Root to shoot ratio, TDW = total dry weight, RWC = relative water content, SD = Standard deviation.

Table-3 : Correlation between six drought related traits in cotton.

Control/Treatment	PRL	RDW	SDW	RSR	TDW	RWC
PRL	1.000	-0.032	0.514**	-0.265	0.420*	0.103
RDW	0.083	1.000	0.527**	0.768***	0.707***	-0.027
SDW	0.202	0.813***	1.000	-0.086	0.974***	-0.173
RSR	-0.215	0.543**	-0.009	1.000	0.134	0.108
TDW	0.178	0.890***	0.989***	0.132	1.000	-0.153
RWC	-0.018	-0.315	-0.368	0.019	-0.366	1.000

PRL = Primary root length, RDW = Root dry weight, SDW = Shoot dry weight, RSR = Root to shoot ratio, TDW = total dry weight, RWC = relative water content, The upper and lower diagonals indicates the correlation coefficients between the same traits under control and treatment conditions, respectively.

Yaganti, NDLA-2985, NDLA-3116-4, NDLA-2953, NDLA-3005, NDLA-3066, NDLA-2974, NDLA-3014, NDLA-3038, NDLA-3043, NDLA-3037, NDLA-2946, NDLA-2930, NDLA-2963, NDLA-2965, NDLA-3028, NDLA-2958, NDLA-2976,NDLA-3020, NDLA-3094, NDLA-3104-4, NDLA-3113. The experiment was carried out at Polyhouse, Regional Agricultural Research Station, Nandyal, Andhra Pradesh, India using Completely Randomized Design (CRD). The genotypes grown under both stress (treatment) and non-stress (control) conditions were watered till the development of the first true leaf, and thereafter, genotypes grown under controlled condition only were watered daily. Water stress condition was created by withholding water supply to the genotypes grown under treatment. The experiment was continued for 45 days from the date of emergence of the seedlings (8).

The data related to drought *i.e.,* primary root length, root dry weight, shoot dry weight, root to shoot ratio, total dry weight, relative water content were recorded from the pot culture experiment. Further, the recorded data were subjected to the analysis of variance, descriptive statistics and correlation analysis using STAR (Statistical tool for Agricultural Research) 2.1.0 software (9).

Results and Discussion

The set of 24 desi cotton genotypes were evaluated for identifying drought tolerance under both controland treatment conditions. The Analysis of variance revealed the presence of significant differences for all the traits among the genotypes (Table-1). Significant differences were observed for all the traits studied among all the genotypes. The values of coefficient of variation ranges

Table-4 : Genotypic means for studied traits under both control and treatment conditions.

S. No.	NAME	Control						Treatment					
		PRL	RDW	SDW	RSR	TDW	RWC	PRL	RDW	SDW	RSR	TDW	RWC
1.	ARAVINDA	9.57	0.33	1.86	0.18	2.19	93.92	12.39	0.32	0.83	0.38	1.16	85.52
2.	SRINANDI	6.01	0.17	1.11	0.16	1.28	90.89	11.49	0.15	0.62	0.24	0.77	80.55
3.	YAGANTI	7.35	0.17	1.21	0.14	1.38	91.24	17.49	0.14	0.61	0.23	0.75	79.83
4.	NDLA-2985	7.39	0.16	1.12	0.14	1.28	91.25	15.81	0.10	0.33	0.29	0.42	77.21
5.	NDLA-3116-4	8.15	0.23	1.30	0.18	1.53	92.42	12.45	0.11	0.33	0.34	0.44	81.93
6.	NDLA-2953	6.59	0.17	1.01	0.17	1.18	92.08	11.71	0.11	0.55	0.20	0.66	77.96
7.	NDLA-3005	12.87	0.15	1.98	0.08	2.13	90.99	19.90	0.11	1.07	0.10	1.18	75.70
8.	NDLA-3066	9.97	0.23	1.29	0.18	1.52	91.89	12.09	0.16	0.47	0.34	0.63	77.86
9.	NDLA-2974	5.94	0.14	1.03	0.13	1.17	92.00	12.81	0.08	0.29	0.28	0.37	78.22
10.	NDLA-3014	4.90	0.31	1.67	0.18	1.97	92.92	9.43	0.12	0.41	0.30	0.53	75.22
11.	NDLA-3038	6.10	0.14	0.94	0.15	1.08	91.55	8.83	0.08	0.35	0.23	0.44	74.56
12.	NDLA-3043	5.75	0.15	0.92	0.16	1.07	91.88	9.70	0.11	0.51	0.22	0.62	76.50
13.	NDLA-3037	6.67	0.14	0.92	0.15	1.06	93.41	17.67	0.10	0.51	0.20	0.61	73.94
14.	NDLA-2946	5.77	0.13	0.91	0.14	1.04	91.97	25.77	0.09	0.50	0.18	0.59	74.01
15.	NDLA-2930	7.20	0.39	1.45	0.27	1.84	92.96	16.80	0.29	0.99	0.29	1.28	77.79
16.	NDLA-2963	6.93	0.48	1.57	0.31	2.05	93.76	16.43	0.46	1.39	0.33	1.85	76.33
17.	NDLA-2965	12.13	0.39	2.22	0.17	2.60	92.79	15.10	0.29	1.52	0.19	1.81	77.08
18.	NDLA-3028	6.90	0.37	2.02	0.18	2.39	88.09	12.77	0.30	1.35	0.22	1.65	68.98
19.	NDLA-2958	4.90	0.52	1.97	0.26	2.49	90.20	12.53	0.42	1.37	0.31	1.79	70.80
20.	NDLA-2976	6.78	0.53	1.55	0.34	2.08	89.79	13.70	0.43	1.25	0.35	1.68	67.29
21.	NDLA-3020	7.10	0.32	0.99	0.32	1.31	90.88	10.43	0.24	0.69	0.34	0.93	72.39
22.	NDLA-3094	6.97	0.36	0.92	0.39	1.28	91.94	14.13	0.29	0.67	0.44	0.96	72.35
23.	NDLA-3104-4	4.97	0.32	0.99	0.32	1.31	92.61	11.87	0.24	0.64	0.37	0.87	74.66
24.	NDLA-3113	7.30	0.46	1.22	0.38	1.68	93.59	21.30	0.41	0.99	0.42	1.40	76.93

PRL = Primary root length, RDW = Root dry weight, SDW = Shoot dry weight, RSR = Root to shoot ratio, TDW = total dry weight, RWC = relative water content.

from 2.67 for RWC to 19.05 for PRL. The maximum value of heritability (0.98) is seen for RDW whereas the minimum value of heritability (0.33) is seen for Primary root length. (10) observed the presence of significant differences for all the drought traits among eight genotypes.Higher broad-sense heritability estimates were found for all the studied traits. (11) observed genotypic differences for all the morphological and physiological traits revealed highly significant differences except transpiration rate. (12) reported the interaction between genotype and water regime (G × W) was highly significant for root length, shoot length, excised leaf water loss and stomatal conductance. A positively strong correlation was found in transpiration rate with relative water content and stomatal conductanceand relative water content with photosynthesis under drought conditions. (9) showed that the significant differences between genotypes in each of the experiments manifests the high variability with respect to drought stress index, and the interaction genotype-location shows the differential behaviour of the genotypes over locations or environments.

The descriptive statistics of six evaluated traits pertaining to 24 studied genotypes were presented in Table 2. The traits primary root length and root shoot ratio were significantly higher under stress condition indicating that these can be used for screening large scale germplasm for drought tolerance ability. Standard deviation values range from 0.09 for RSR to 2.04 for PRL under control and 0.08 for RSR to 4.05 for PRL. The traits root dry weight, shoot dry weight, total dry weight and relative water content were significantly higher under water controlled conditions. (2) considered root to shoot ratio as an important parameter for evaluation of drought stress. Under irrigated conditions, FH?142 had the highest root to shoot ratio (1.68), whereas under stress conditions, IUB-222 had the highest mean value (1.49), followed closely by N-111 (1.48). (12) revealed that significant variation among the genotypes was found for all the traits under study at 5% level of significance except for trait stem diameter. (13) analyzed a genome wide comparative analysis of contrasting cotton species to identify drought mechanisms in drought stressed cotton plants.

The Pearson's correlation coefficients between the evaluated six drought related traits in 24 desi cotton breeding lines under both control and treatment conditions were presented in Table-3. From the correlation analysis, it is observed that the trait primary

root length showed significant and positive correlation (r = 0.514) with shoot dry weight and (r=0.420) with total dry weight. The trait root dry weight recorded significant and positive correlation with shoot dry weight (r = 0.527), root to shoot ratio(r=0.768) and total dry weight (r=0.707). The trait shoot dry weight recorded significant and positive correlation with root dry weight (r = 0.813), total dry weight(r=0.974). The correlation coefficients between drought related traits including root to shoot ratio androot dry weight were significant and positive with each other, the trait total dry weight showed positive and significant correlation with root and shoot dry weights. (14) observed that there was a significant and positive correlation between fresh shoot weight and fresh root weight, dry shoot weight, plant weight and dry root weight. (15) reported that correlation analysis revealed overall positive associations among almost all traits, except root to shoot ratio and root diameter, which were negatively correlated with a few traits. The root to shoot ratio was exceptional in not being significantly correlated with any other trait except stem dry weight (-0.28).

The detailed mean values of evaluated 24 genotypes for economic traits in cotton were presented in Table-4. For Primary root length, the genotypes NDLA-3014 and NDLA-2958 recorded lowest mean value of 4.90, while the genotype NDLA-3005 recorded highest mean value of 12.87under controlled condition and the genotype NDLA-3038 recorded lowest mean value of 8.83, while the genotype NDLA-2946 recorded highest mean value of 25.77 under stress condition. For root and shoot dry weights, the genotype NDLA-2946 recorded lowestmean values of 0.13 and 0.91 respectively and the genotypes NDLA-2976 and NDLA-2965recorded highest mean values of 0.53 and 2.22 respectively in controlled condition. For root dry weights, the genotype NDLA-2974 and NDLA-3038 recorded lowest mean value of 0.08, highest mean of0.46 for NDLA-2963 andfor shoot dry weights, the genotype NDLA-2974 recorded lowest mean value of 0.29 and highest of 1.52 for NDLA-2965. Under controlled condition, the highest and lowest mean root to shoot ratio was recorded by genotypes NDLA-3094 (0.39) and NDLA-3005 (0.08), respectively. Under treatment, the highest and lowest mean root to shoot ratio was recorded by genotypes NDLA-3094 (0.44) and NDLA-3005 (0.10), respectively. Under control, the highest and lowest mean total dry weight was recorded by genotypes NDLA-2965 (2.60) and NDLA-2946 (1.04), respectively. Under treatment, the highest and lowest mean total dry weight was recorded by genotypes NDLA-2963 (1.85) and NDLA-2974 (0.37), respectively. For control, the highest and lowest mean relative water content was recorded by genotypes Aravinda (93.92) and NDLA-3028 (88.09), respectively. Under treatment, the highest and lowest mean relative water content was recorded by genotypes Aravinda (85.52) and NDLA-2976 (67.29), respectively. (16) observed that mean for all the root parameters under controlled were ranged from 6.77cm for (MS-64) to 13.97 cm for DPL-45. On the average basis DPL-45 had maximum root length (11.56cm) followed by BH-176 (11.42 cm). Tree cotton (11.33cm) and MPS-11 (10.72 cm). These genotypes performed better in all the conditions and these are considered as drought tolerant genotypes. Due to drastic reduction in root length in stressed condition, these accessions may be rated as susceptible to water stress.Mean values of seedcotton yield, number of bolls per plant and boll weight of genotypesin the well-watered and waterlimited regimes for 2003 and 2004 are summarized.

Conclusions

In this study, results of genetic analysis of 24 diverse desi cotton genotypes showed the presence of significant differences for all the drought tolerance related traits among the genotypes. The genotypes NDLA 2963, NDLA 2965, NDLA 2958, NDLA 2976 and NDLA 3028 were shown higher total and shoot biomass under stress condition and found to be tolerant.Further, these genotypes could be grown under field conditions to test their natural tolerance ability. The identified genotypes are potential resources for drought tolerance improvement in desi cotton.

References

1. Radin J.W., Reaves L.L., Mauney J.R. and French O.F. (1992). Yield enhancement in cotton by frequent irrigations during fruiting. *Agron.*, 84: 551-557.
2. Iqbal M., Allah S.M., Naeem M., Ijaz M. and Ahmad M.Q. (2020).Genotypic Varýabýlýtyand Assocýatýon between Seed Traýts and Seedlýng Výgor in Upland Cotton. *Pakistan Journal of Agricultural Research,* 33(2): 337-343.
3. Chittapur, B.M., Vinayak Hosamani, A.S. Halepyati and Satyanarayana Rao (2020). Site specific nutrient management (SSNM) for targeted yield in bt cotton (*Gossypium hirsutum*). *Progressive Research–An International Journal,* 15(1): 14-18.
4. Sabagh A.E., Hossain A., Islam M.S., Barutcular C., Ratnasekera D., Gormus O., Amanet K., Mubeen M., Nasim W., Fahad S., Tariq M., Llanes A., Meena R.S., Ueda A.,Saneoka H., Emran M. and Hassanuzzaman M. (2020). Drought and Heat Stress in Cotton (*Gossypium hirsutum* L.): Consequences and Their Possible Mitigation Strategies. *Agronomic Crops*, 613-614.
5. Rani Chapara and Sudharani Madugula (2021). Heterosis for fibre quality traits in cotton (*Gossypium hirsutum* L.). *Frontiers in Crop Improvement,* 9(2): 136-140.
6. Wang C.Y., Isoda A., Li M.S. and Wang D.L. (2007). Growth and eco-physiological performance of cotton under water stress conditions. *Agriculture Sciences*, 6: 949–955.
7. Anwar M., Saleem M.A., Dan M., Malik W., Allah S.M.,

Ahmad M.Q., Qayyum A., Amjid M.W., Zia Z.U., Afzal H., Asif M., Rahman M.A.U. and Hu Z. (2022). Morphological, physiological and molecular assessment of cotton for drought tolerance under field conditions. *Saudi Journal of Biological Sciences,* 29: 444–452.

8. Dahab A.A., Saeed M., Hamza N.B., Mohamed B.B. and Husnain T. (2016). Linkage disequilibrium and association mapping of drought tolerance in cotton (*Gossypium hirsutum* L.) germplasm population from diverse regions of Pakistan. *African Journal of Biotechnology,* 15(46): 2603-2612.
9. Gulles A.A., Bartolome V.I., Morantte R.I.Z.A., Nora L.A., Relente C.E.N., Talay D.T.,Caneda A.A. and Ye G. (2014). Randomization and analysis of data using STAR (Statistical Tool for Agricultural Research). *Philippine Journal of Crop Science,* 39(1): 137.
10. Riaz M., Farooq J., Sakhawat G., Mahmood A., Sadiq M.A. and Yaseen M. (2013).Genotypic variability for root/shoot parameters under water stress in some advanced lines of cotton (*Gossypium hirsutum* L.). *Genetics and Molecular Research,* 12(1): 552-561.
11. Zahid Z., Khan M.K.R., Hameed A., Akhtar M., Ditta A., Hassan H.M. and Farid G. (2021). Dissection of Drought Tolerance in Upland Cotton Through Morpho-Physiological and Biochemical Traits at Seedling Stage. *Frontiers in Plant Science*, 12: 627107.
12. Parre S. and Patil R.S. (2021). Correlation studies and path coefficient analysis of yield attributing traits among selected F_2 populations of intra-hirsutum cotton hybrids under rainfed situation. *The Pharma Innovation Journal,* 10(3): 942-950.
13. Hasan M.M.U., Ma F. Islam F., Sajid M., Prodhan Z.H., Li F., Shen H., Chen Y. and Wang X. (2019). Comparative Transcriptomic Analysis of Biological Process and Key Pathway in Three Cotton (*Gossypium* spp.) Species Under Drought Stress. *International Journal of Molecular Sciences,* 20: 2076.
14. Asif M., Khan A.A., Cheema H.M.N., Khan S.H. and Iqbal Z. (2022).Genetic variability in diverse cotton germplasm for drought tolerance. *Pakistan Journal of Agricultural Sciences,* 59(1): 63-74.
15. Ayubov M.S., Norov T.M., Saha S., Tseng T.M., Reddy K.R., Jenkins J.N.,Abdurakhmonov I.Y. and Stelly D.M. (2021). Alteration of root and shoot morphologies by interspecific replacement of individual Upland cotton chromosome or chromosome segment pairs. *Euphytica*, 217: 154.
16. Akbar M. and Hussain S.B. (2018). Assessment of drought tolerant cotton genotypes based on seedling & physiological attributes at different moisture levels. *Pure and Applied Biology,* 8(1): 93-107.
17. Rahman M., Ullaha I., Ahsraf M., Stewart J.M. and Zafara Y. (2008). Genotypic variation for drought tolerance in cotton. *Agronomy for sustainable Development*, 28(3): 439-447.